

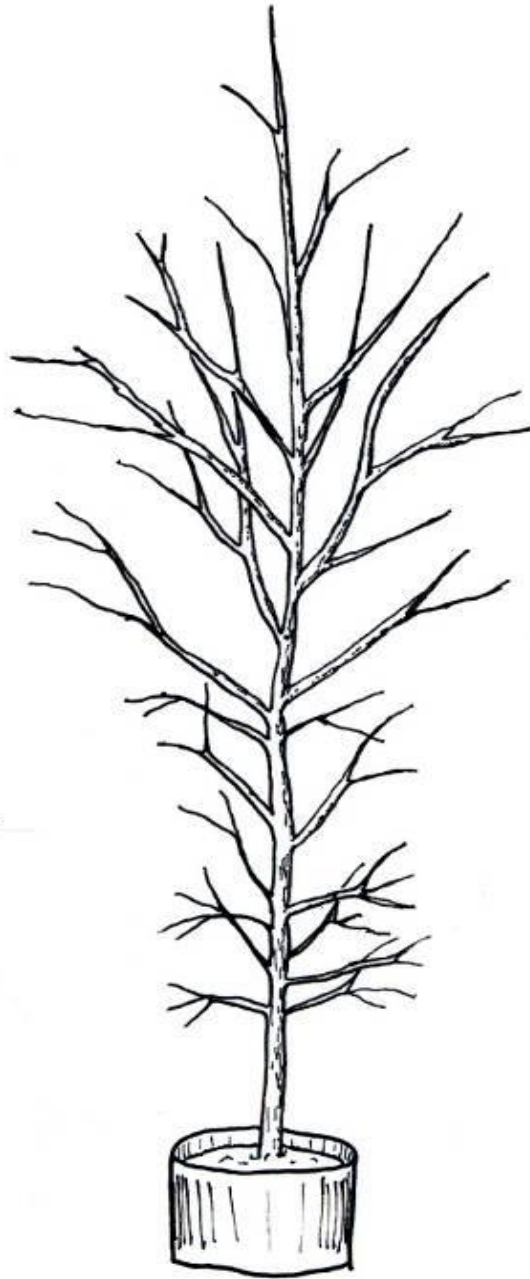
California Department of Forestry & Fire Protection



Urban Forestry Grant Programs Technical Specifications and Guidelines 2010/2011

(Note: Adopted from Urban Tree Foundation and UC Cooperative Extension Publications.)

Guideline Specifications for Nursery Tree Quality



Revision 2009

BACKGROUND

This document is a revision of a previous publication entitled *Guideline Specifications for Nursery Tree Quality*, published by the Urban Tree Foundation, which was developed by a committee of horticulture professionals from the nursery, landscape, municipal, consulting, and academic sectors. The original publication has been posted online at the Foundation's Web site (<http://www.urbantree.org/specs.asp>) since 2002 and has been used by public, private, and nonprofit groups to select and specify quality nursery trees. Recommendations for improvements to the document received in the past 5 years have been incorporated in this 2009 revision.

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Adaptions from *Arboriculture: Integrated Management of Landscape Trees, Shrubs and Vines*, 4th ed., by R. W. Harris, J. R. Clark, and N. P. Matheny (Prentice Hall, 2003).

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Introduction

This document provides specifications for selecting and specifying quality nursery trees in California, with a focus on container stock. Key traits of nursery trees are identified and described to provide growers and buyers with the information they need to distinguish good-quality stock from poor-quality stock. Structural and health characteristics are described, as well as labeling, compliance with laws and regulations, and inspection of nursery stock. If a particular defect or substandard element can be corrected easily, appropriate remedies should be applied as agreed upon by both parties.

I. GENERAL SPECIFICATIONS

A. Proper Identification: All trees shall be true to name as ordered or shown on planting plans and shall be labeled individually or in groups by species and cultivar (as appropriate).

B. Compliance: All trees shall comply with federal and state laws and regulations requiring inspection for plant disease, pests, and weeds. Inspection certificates required by law shall accompany each shipment of plants. Clearance from the local county agricultural commissioner, if required, shall be obtained before planting trees originating outside the county in which they are to be planted. Even though trees may conform to county, state, and federal laws, the buyer may impose additional requirements.

C. Inspection: The buyer reserves the right to reject trees that do not meet specifications as set forth in these guidelines or as adopted by the buyer. If a particular defect or substandard element can be corrected easily, appropriate remedies shall be applied. If destructive inspection of a root ball is to be done, the buyer and seller should have a prior agreement as to the time and place of inspection, number of trees to be inspected, and financial responsibility for the inspected trees.

D. Delivery: The buyer shall stipulate how many days prior to delivery that delivery notification is needed. Buyer shall stipulate any special considerations to the nursery prior to shipment.

II. HEALTH AND STRUCTURE SPECIFICATIONS

These specifications apply to deciduous, broadleaf evergreen, and coniferous species. They do not apply to palms. Note that leaf characteristics will not be evident on deciduous trees during the dormant season.

A. Tree Health

1. Crown: The form and density of the crown shall be typical for a young specimen of the species or cultivar. Changes in form caused by wind, pruning practices, pests, or other factors shall not substantially alter the form for the species or cultivar.

2. Leaves: The size, color, and appearance of leaves shall be typical for the time of year and stage of growth of the species or cultivar. Trees shall not show signs of prolonged moisture stress as indicated by wilted, shriveled, or dead leaves.

3. Branches: Shoot growth (length and diameter) throughout the crown should be appropriate for the age and size of the species or cultivar. Trees shall not have dead, diseased, broken, distorted, or otherwise injured branches.

4. Trunk: The tree trunk shall be relatively straight, vertical, and free of wounds (except properly made pruning cuts), sunburned areas, conks (fungal fruiting bodies), wood cracks, bleeding areas, signs of boring insects, galls, cankers, girdling ties, or lesions (mechanical injury).

5. Roots: The root system shall be substantially free of injury from biotic (e.g., insects and pathogens) and abiotic (e.g., herbicide toxicity and salt injury) agents. Root distribution shall be uniform throughout the container substrate, and growth shall be appropriate for the species or cultivar. At time of inspection and delivery, the root ball shall be moist throughout. Roots shall not show signs of excess soil moisture conditions as indicated by stunted, discolored, distorted, or dead roots.

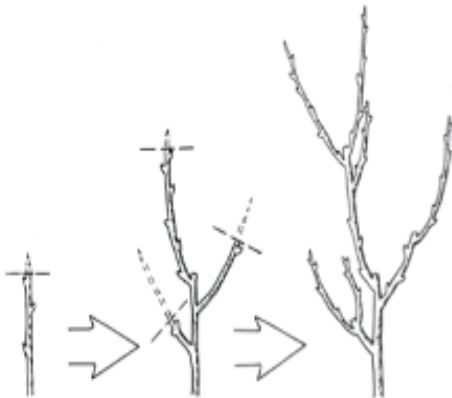
B. Tree Crown

Note: Crown specifications do not apply to plants that have been specifically trained in the nursery as topiary, espalier, multistem, clump, or unique selections such as contorted or weeping cultivars.

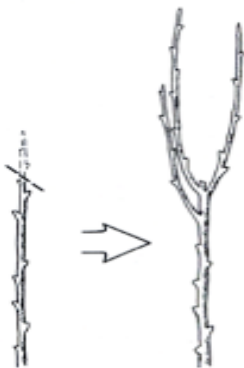
1. Trees shall have a single, relatively straight central leader. They shall be free of codominant stems and vigorous, upright branches that compete with the central leader. If the original leader has been headed, a new leader at least one-half of the diameter of the original leader shall be present.



Not topping is desirable.



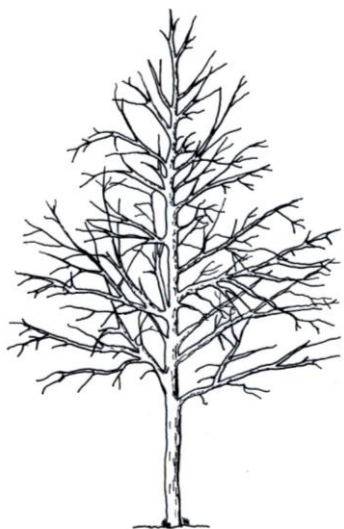
Topping and retaining a leader is desirable.



Topping without retaining a leader is not desirable.



2. Main branches shall be well distributed along the central leader not clustered together. They shall form a balanced crown appropriate for the cultivar/species.



Desirable



Not Desirable



3. Branch diameter shall be no larger than two-thirds (one-half is preferred) the diameter of the central leader measured 1 inch above the branch.



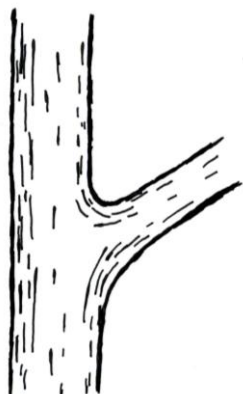
Desirable



Not Desirable



4. The attachment of the largest branches (scaffold branches) shall be free of included bark.



Desirable



Not Desirable



5. Temporary branches, unless otherwise specified, should be present along the lower trunk below the lowest main (scaffold) branch, particularly for trees less than 1 inch in caliper. These branches should be no greater than 3/8 inch diameter. Clear trunk should be no more than 40% of the total height of the tree.



Desirable



Not Desirable



C. Trunk

1. The trunk shall be free of wounds (except properly-made pruning cuts), sunburned areas, conks (fungal fruiting-bodies), wood cracks, bleeding areas, signs of boring insects, galls, cankers and/or lesions.

2. Trunk caliper and taper shall be sufficient so that the tree will remain vertical without a stake. Trunk caliper at 6 inches above the soil media (substrate) surface shall be within the diameter range shown for each container size below:

Container Size -----Trunk Diameter

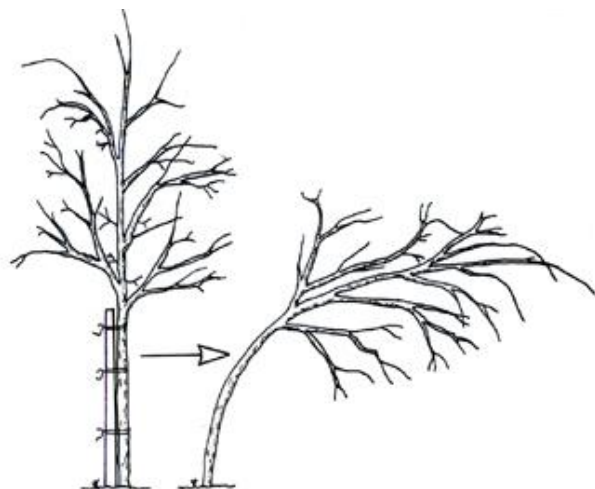
5.....0.5" to 0.75"

15.....0.75" to 1.5"

24-inch box.....1.5" to 2.5"



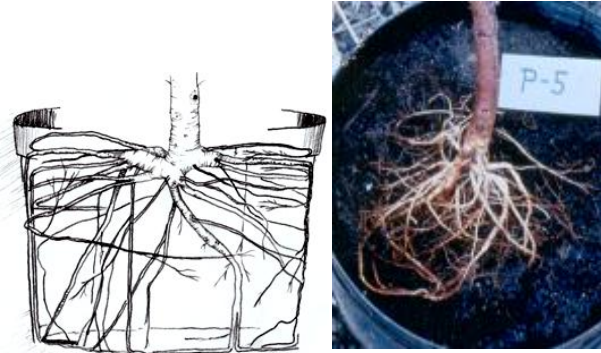
Desirable



Not Desirable

D. Roots

1. The uppermost roots or root collar (root crown) shall be within the upper 2 inches of the soil media (substrate).
2. The root collar and the inside portion of the root ball shall be free of defects, including circling, kinked, and stem girdling roots. Soil removal near the root collar may be necessary to inspect the aforementioned root defects.



Desirable



Not Desirable

3. Roots on the periphery and bottom of the root ball shall be less than 1/4 inch in diameter (1/8 inch is preferred). The maximum acceptable root diameter on the periphery should be indicated.



Desirable



Not Desirable

4. The tree shall be well rooted in the soil media (substrate). Root distribution shall be uniform throughout the container media. Structure and growth shall be appropriate for the species/cultivar. When the container is removed, the root ball shall remain intact. When the trunk is lifted both the trunk and root system shall move as one.
5. At the time of inspection and delivery, the root ball shall be moist throughout. The crown shall show no signs of moisture stress as indicated by wilted, shriveled, or dead leaves or branch dieback. The roots shall show no signs of excess soil moisture as indicated by poor root growth, root discoloration, distortion, death, or foul odor.

III. INSPECTION

The buyer reserves the right to reject trees that do not meet specifications as set forth in these guidelines or as adopted by the buyer. If a particular defect or substandard element or characteristic can be easily corrected, appropriate remedies are encouraged. If destructive inspection of a root ball or balls is to be done, the buyer and seller should have a prior agreement as to the time and place of inspection, minimum number of trees to be inspected or percentage of a species or cultivar, and financial responsibility for the inspected trees.

VI. DELIVERY

The buyer should stipulate how many days prior to delivery that notification is needed.

GLOSSARY:

caliper. **Trunk** diameter measured 6 inches from the ground; if caliper is greater than 4 inches, the caliper measurement is taken at 12 inches from the ground.

central leader. A continuation of the main trunk located more or less in the center of the crown, beginning at the lowest main branch (scaffold) and extending to the top of the tree. Also referred to as the **dominant leader**.

circling roots. One or more roots whose diameter is greater than 10% of the trunk caliper circling more than one-third of the trunk.

clear trunk. The portion of the trunk below the crown lacking lateral branches; this includes the portion of the trunk with shortened temporary branches that are below the main crown.

codominant. Two or more vigorous, upright branches or stems of relatively equal size that originate from a common point, usually where the leader was lost or removed.

crown. The portion of a tree beginning at the lowest main (scaffold) branch extending to the top of the tree.

cultivar. A named plant selection from which identical or nearly identical plants can be produced, usually by vegetative propagation or cloning.

included bark. Bark embedded in the union between a branch and the trunk or between two or more stems that prevents the formation of a normal branch bark ridge.

kinked root. A main mother root that is sharply bent.

leader. The dominant stem that usually develops into the main trunk.

photosynthate. Sugar and other carbohydrates that are produced by the foliage and stems during photosynthesis.

root collar. The base of a tree where the main roots and trunk meet. Also referred to as the **root flare**.

scaffold branches. Large main branches that form the main structure of the crown.

stem-girdling root. A circling, bent, or straight root that touches or rests on the trunk or root flare that can become a permanent root.

temporary branch. A small branch that is temporarily retained along the lower trunk of young trees.

trunk. The main stem of a tree, beginning at the root collar and ending at the lowest main scaffold branch.

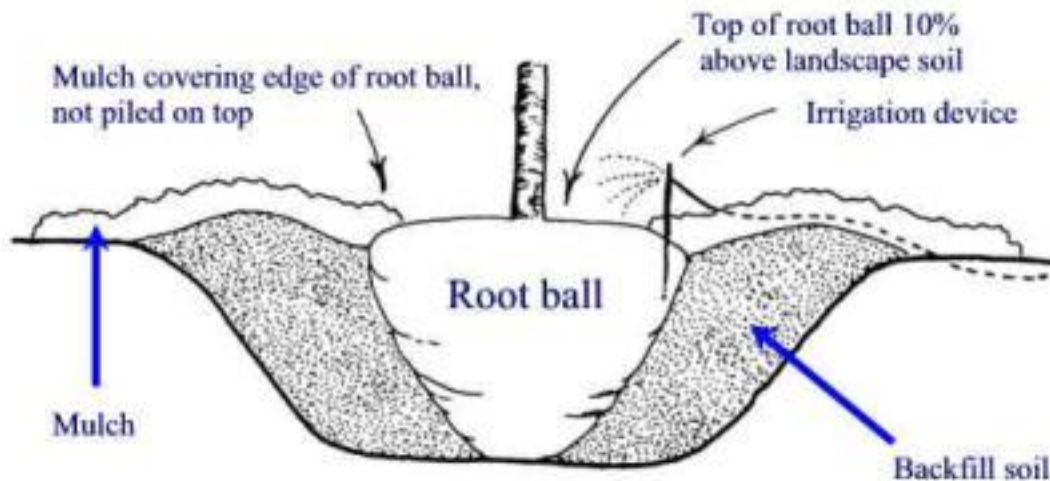
taper. The thickening of a trunk or branch toward its base.

Tree Planting Specifications

- 1) All tree planting stock to be planted using these "Planting Specifications" shall conform at minimum to the "Guideline Specifications For Nursery Tree Quality" above.
- 2) Trees are to be planted in accordance to the landscape plan as well as adhering to current recognized horticultural practices.
- 3) Trees shall be planted so that the root ball is equal to or slightly higher than the surrounding soil surface. **Shallow is better than deep! Most people plant trees too deep. A hole three times the width of the root ball is often recommended but about one-and-one half the diameter is more common. Roots can become deformed by the edge of the hole in compacted or clayey soils if it is too small. The depth of the hole should be LESS than the height of the root ball, especially in compacted or natural wet soils. If the hole was inadvertently dug too deep, add soil and compact it with your foot. Breaking up compacted soil in a large area (out of the drip line of the tree) around the tree provides the newly emerging roots room to expand into loose soil. This will hasten root growth translating into quicker establishment.**

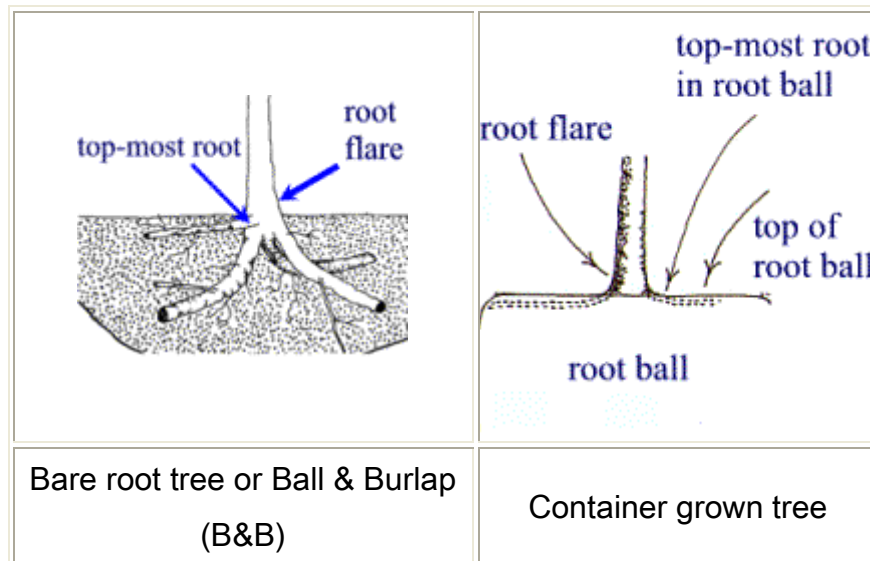
Proper Planting Detail

If you form a berm of soil around the root ball to hold irrigation, keep it less than about 4 inches high. Water held in a taller berm simply runs through the root ball. It might be more appropriate to make the berm from mulch since the berm typically ends up on top of the root ball eventually. Placing soil over the root ball cuts off oxygen and water.

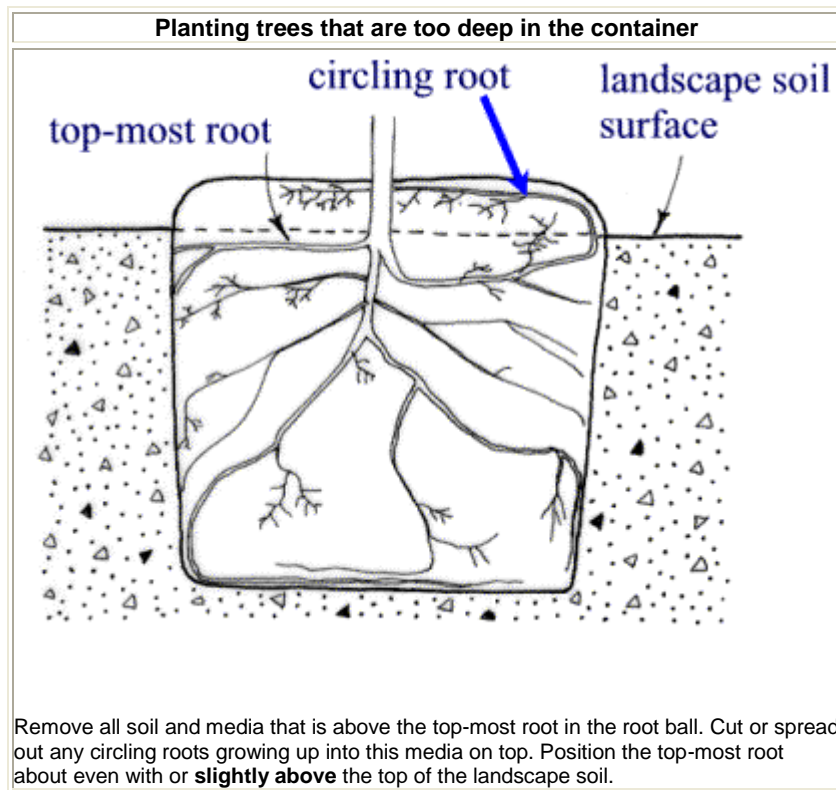


When planting on slopes set the tree so the top-most root in the ball on the uphill side is about even with the soil. The side of the root ball on the downhill side will be well above the surrounding soil. Bring in enough soil to cover the sides of the root ball with soil. Apply mulch to finish the planting job as shown in the diagram above.

- 4) The trunk flare (root crown) shall be evident and free of any container soil and/or planting backfill. **The trunk flare (root flare, root crown) is the abrupt swelling where roots join the trunk. This point should be visible at the top of the root ball. If the trunk flare is not visible, remove soil or media from the top of the ball until it is visible.**



- 5) The root flare shall be slightly above the surface of the surrounding soil at all times. When planting on a sloping site, the top-most root in the root ball shall be even with the grade on the uphill side of the tree. **Site soil will need to be added on the downhill side to cover the sides of the root ball and to construct the soil berm to hold water. It is better to plant the tree a little high than to plant it too deep. If the tree is a little deep, tip it to one side and slide some soil under it; then tip it back the other way and slide some more soil under the root ball. Continue this until it is set at the appropriate depth. Once it is at the appropriate depth, place a small amount of soil around the root ball to stabilize it. Soil amendments should only be used as needed. The soil removed from the hole generally makes the best backfill.**
- 6) Tree stock will be protected from excessive vibration; avoiding being thrown or bounced off mobile equipment to the ground. Trees shall not be dragged, lifted, or pulled by the trunk or foliage parts in a manner that will loosen the roots in the ball. **To avoid damage when setting the tree in the hole, lift the tree with straps or rope around the root ball, not be the trunk. Special strapping mechanisms need to be constructed to carefully lift trees out of large containers.**
- 7) Planted trees shall exhibit no circling root conditions or evidence of untreated root bound container stock. Check rooting structure of the container tree for possible root bound conditions and implement corrections if needed.



Pot bound (also called root bound) root balls from containers have large or many roots on the outer edge of the ball. It is best not to plant trees in this condition because roots could girdle the trunk as the tree grows. The tree could also become unstable later because few supporting roots grow from the outside curved portion of a root. If you must plant a tree with circling roots, these roots should be cut with a knife or pruning tool to prevent them from girdling the tree later, especially if they are near the top of the root ball. Make three or four slices in inch deep from the top of the root ball to the bottom. If in doubt about whether a root is large enough to cut, go ahead and cut it. Research shows that if there is a growth reduction from root pruning container grown trees at planting, the effect is negligible. Other work shows a reduction in shoot growth following root slicing if plants are under irrigation. Recent studies show that slicing the root ball from the top to bottom in several locations does not increase root growth after planting. It does; however, appear to enhance distribution of regenerated roots in the backfill soil profile. Instead of growing almost exclusively from the bottom of the root ball, slicing encourages root regeneration along the slices from the top to the bottom of the root ball. This could help establish the plant quicker by allowing the roots to quickly explore a larger volume of backfill soil.

8) Trees shall all be planted in an upright position avoiding appearances of leaning. **Before you begin backfilling, have someone view the tree from two directions perpendicular to each other to confirm the tree is straight. Fill in with some more backfill soil to secure the tree in the upright position. Once you add large amounts of backfill, it is difficult to reposition the tree.**

9) Planting tree site (hole) shall reflect proper techniques in the use of backfill soil materials to avoid evidence of large air pockets/voids within the backfill soil profile. **Attempt to break up clayey soil clumps as much as possible. Do NOT step firmly on the backfill soil because this could compact it and restrict root growth, especially in clayey soil. Fill the hole around the root ball with soil. When the hole is filled with soil, the root ball should remain 2 to 3 inches above the backfill soil. Slice the shovel 20 to 30 times into the backfill to settle the soil. Add 10 to 20 gallons of water to the root ball and backfill. Fill in any holes or depressions with additional backfill soil. Do not firmly pack backfill soil in an attempt to**

eliminate air pockets because this could cause too much soil compaction. The water infiltrating the backfill soil will eliminate the large air pockets. The presence of small air pockets could even be of benefit because they could allow more air to reach the roots.

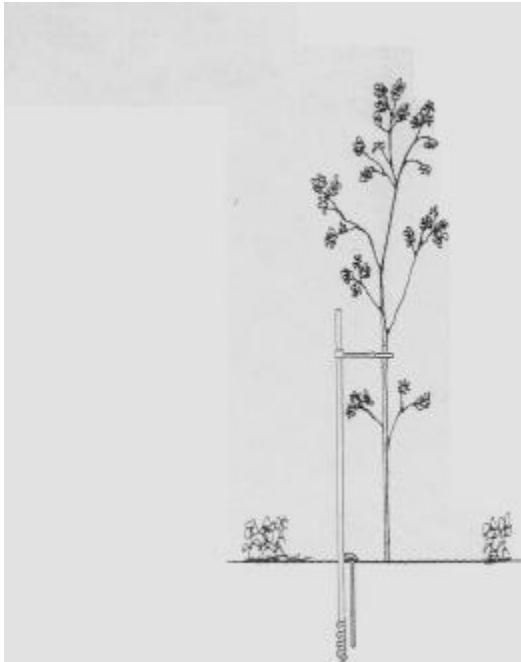
10) All synthetic materials from around the tree trunk and root ball shall be removed and not evident within the backfill soil mix. **String, rope, synthetic burlap, plastic, strapping, and other materials that will not decompose in the soil shall be removed at planting.**

11) Optional treatment: Cover the planted tree root ball area with mulch. **Apply mulch material to at least a 6-foot diameter circle around the tree. Construct a berm out of mulch at the edge of the root ball only if the tree will be watered with a hose, bucket, or other high volume means. Constructing a berm in all other situations will not provide more water to the root system. Do not construct a berm from soil since this soil could end up over the root ball several months later. Water the mulch well after it is spread. Mulching: Weed and turf suppression during establishment is essential. Application of 4+ inches of mulch (after settling) is highly recommended to help discourage weeds. This area should be maintained during the establishment period at least two feet in diameter for each inch of tree trunk diameter (minimum diameter should be six feet for trees with a trunk diameter less than 3 inches). If you wish to place mulch over the root ball, apply only a thin layer over the outer half of the root ball. This keeps the trunk dry and allows rainwater, irrigation, and air to easily enter the root ball area.**

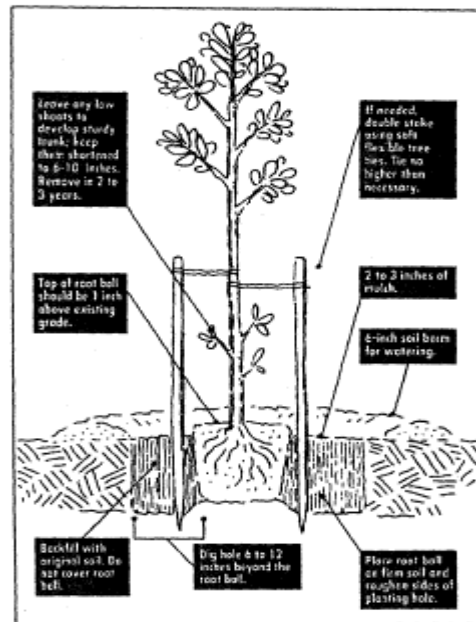
12) Support trunk staking that was supplied with the container tree has been removed. **Many nursery vendors provide single or double support tree stakes to minimize trunk/crown damage during transporting activities. These support stakes left on the young tree after it is planted in the ground will often inflict wounds to the trunk and lower limbs of the young tree. This transport staking is not needed when 1) proper caliper in tree stock diameter is adhered to in the tree purchase process and/or 2) proper support staking discussed under item 13 below is utilized and installed correctly.**

13) Proper tree staking utilized, if necessary. **If the root ball moves in the wind, emerging roots could break and the trees will establish slowly. Staking to hold a weak trunk upright should not be necessary on trees with a trunk diameter more than about 1.5 inches. If large trees require staking to prevent the trunk from bending, it probably indicates a lesser quality tree (reflecting a failure to meet minimum container nursery stock purchase specifications). Smaller trees might require staking until enough trunk strength develops. Trees could establish more quickly and develop a slightly stronger trunk and root system if they are NOT staked at the time of planting; assuming quality nursery stock is utilized. Should staking be utilized, the following staking systems will be considered as minimum standards: *Double Stake Support System, ReddyStake Support System, Alternative Staking System as illustrated.***

Reddy Stake Support System



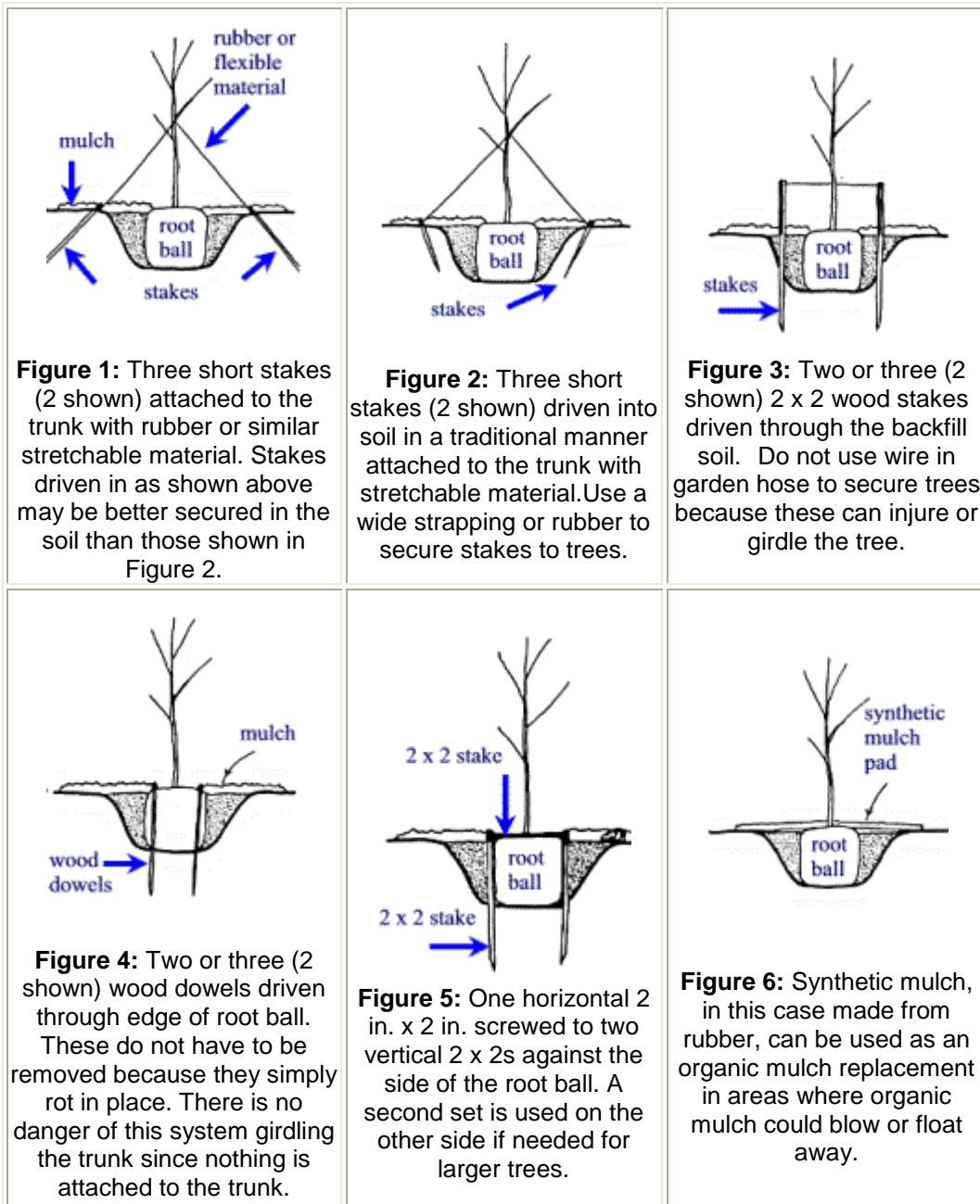
Double Stake Support System



Alternative Staking Systems

Container and bare root trees often require stakes to hold them firm in the soil until roots become established. Root balls must remain firm and stable in the soil so the fragile new roots growing into the backfill soil are not broken as the root ball moves in windy weather.

Traditional staking systems are shown in Figures 1-3. All three traditional systems require removal within one year after planting. Figures 4 and 5 show two systems used successfully by urban foresters throughout the country. Both of these inexpensive alternate systems eliminate the requirement to return to the tree to remove the staking system because they simply decay in a few years. Figure 6 shows an alternative, synthetic mulching material useful along streets and highway medians. Tree shelters or plastic tubes can increase survival of very small seedlings, but may have little or no use for standard sized planting stock. Their use has been associated with retarded trunk diameter growth, damage from birds, mechanical damage from trunks rubbing in the tube, ice and snow loading damage, reduced root systems, and delayed dormancy.



MINIMUM MAINTENANCE REQUIREMENTS

1. Provide a minimum of weekly watering during the dry season. Keep turf and ground covers at least 18 inches away from edge of root ball. Use some type of organic mulch to retain moisture.
2. Provide developmental pruning for strong and characteristic structure at three (3) years old and again at seven (7) years old as a minimum service level.
3. Provide needed pest control for the health of the tree.
4. Provide required staking to ensure stability and proper growth. Remove the nursery stake and use 2 stakes placed outside the root ball and tie loosely with soft, flexible tree ties to allow for some movement.
5. Stake trees until the tree is capable of supporting itself in windy conditions, usually for one to two seasons.

WATER USE CLASSIFICATION FOR LANDSCAPE SPECIES

A Guide to the Water Needs of Landscape Plants

Revised 4/1/94

L. R. Costello

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K. S. Jones

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RECOMMENDED WATERING PRACTICES:

- Irrigate trees planted during the dry season 2 to 3 times a week for the first two months and twice a week thereafter until the rainy season. It may be necessary to water more frequently during particularly hot, dry weather.
- Construct a watering berm around the planting hole and a smaller inner temporary berm immediately around the root ball to help retain water.
- Apply water to both basins **immediately** after planting.
- The inner berm will help keep the root ball moist until roots grow out into the fill soil and beyond. (usually 6 to 8 weeks)
- Irrigate trees planted in the late winter to early spring on a weakly basis, when rain is lacking.
- Begin watering twice a week with the approach of warm, dry weather - apply water to wet the soil to the planting hole depth. Keep the soil moist not wet. Too much water is just as bad as too little.
- During the second year, water on a weekly basis beginning in the late spring continuing through early fall. *Water the soil area under the expanding leafy canopy, allowing enough time for the water to penetrate the soil to a depth of 6 to 12". If drip irrigation is used, expand the system as the tree grows.*
- By the third year, monthly deep watering should suffice.
- Many trees will thrive with 2 to 3 deep watering applied during the summer of the fourth or fifth year.
- Some trees will survive the summer with no further irrigation.
- Most trees will benefit from periodic, but infrequent deep watering, particularly during droughts.
- It may be necessary to make adjustments in watering frequency and duration depending on soil type, weather, drainage and tree species.

GUIDELINES FOR STRUCTURAL DEVELOPMENT OF YOUNG TREES

Structural pruning of young trees can improve branch spacing, strengthen branch attachment, reduce hazard potential, maintain or restore natural shape, and lower future maintenance costs. The most economic time to prune young trees is 3 to 5 years following planting; thereafter, pruning costs increase sharply.

At the time of planting, prune only to improve branch spacing, eliminate weakly attached, dead, damaged, rubbing or poorly formed branches. However, more significant pruning may be needed to correct crowded branching in trees topped at the nursery. If present, leave some branches along the lower trunk below the first permanent branch is desired to help shade and nourish the trunk. These 'temporary' branches will help increase stem taper and reduce the chance of sunburned bark. Cut them back to 8 to 12 inch 'spurs' or to several buds to slow their growth and provide adequate clearance. Re-prune as necessary to keep them in bounds. Remove about $\frac{1}{3}$ of the temporary branches each year, leaving the remainder well spaced. As a rule, remove no more than 25 percent of foliage of a new tree. Bear in mind that pruning removes the leaves that make food needed for growth and normal health. Over-pruning can retard establishment, reduces growth, impair health, increases susceptibility to pests, and can result in sunburned bark and/or dense sprouting.

After about 3 to 5 years, evaluate young trees for structure, clearance, defects, natural shape, and prune as needed. Emphasis of structural pruning should be placed on developing a strong, natural looking framework. First priority must be given to the removal of weakly attached (defective) branches those with included bark at their union with the trunk or parent branch, and those that are crowded. Always preserve natural shape and branch structure.

To many untrained practitioners, pruning is the shortening of most if not all of a tree's branches presumably to control size and increase bushiness. Although this does stimulate several to many sprouts to form just below where a cut is made, the resulting shoots are fast growing, upright, crowded, poorly tapered and weakly attached. Furthermore, trees pruned in this manner generally grow back to their original height in several years. Another problem is that lateral growth along the lower portion of the branch and new shoots is poor. Thus, resulting branch structure and trees architecture is irreparably altered. Branches allowed to grow on their own, are generally shorter, well tapered and with normal lateral branching.

GUIDELINES:

- The primary goal of early structural pruning is to establish a tree's basic framework and enhance natural form, rather than reduce size or impose some unnatural growth form.
- Have a reason for removing each branch. Indiscriminant pruning ruins natural shape and architecture and creates structural problems.
- Begin by removing defective (weakly attached) branches, and those growing downward or in an undesirable direction. Remove dead, cankered, damaged, suppressed, and rubbing branches as well as vigorous, trunk sprouts.
- Use 'thinning cuts' to direct growth. A thinning cut removes a branch at its attachment point to another branch or to the trunk, or shortens it to a lateral branch at least $\frac{1}{2}$ its diameter. This allows the remaining lateral to assume the terminal role, while preserving the tree's natural defenses, and encouraging quick closure.
- The term 'thinning' refers to the selective removal of branches, using 'thinning cuts' to improve structure, reduce height, spread, branch weight and wind resistance. Current pruning standards limit the removal of foliage to no more than 25 percent. This 'general rule' is intended to avoid excessive foliage removal. Size reduction using thinning is quite limited, thus trees that are too large for their allotted space should be replaced with more appropriate species. Thinning can also be used to suppress or stimulate branch growth, allowing the practitioner to direct growth or alter the growth pattern of a co-dominant stem.
- Trees that maintain a single, dominant central leader (excurrent growth form) throughout most of their lives, e.g., most conifers and a few hardwoods like liquidambar, usually need little pruning beyond removing or cutting back an occasional competing leader or removing lower laterals below the first permanent scaffold.

- Most trees, unless topped at the nursery or after planting, will have a single, dominant central leader for several or more years. Some trees, like Chinese Pistache, however, may have several leaders while they are very young and appear quite round-headed (decurent growth form). In such cases, little needs to be done other than improve branch spacing and eliminate obvious defects.

Important Steps:

- When there are competing leaders, select the most dominant and upright leader and remove **or** cut back competing leaders to lower lateral branches growing more horizontally.
- Cut back or thin any lower laterals that threaten to compete with the leader.
- Most trees will eventually develop multiple leaders as they age, but it is a good idea to maintain a single dominant leader for as long as practical.
- Select the lowest permanent scaffold branch and cut back or remove competing branches. This position will be determined by the tree's location, e.g., along a street, over a sidewalk, in a park, or on a residential lot etc.
- Next, select vigorous, well-formed and relatively horizontal scaffold branches to form the basic framework of the tree. Prune out competing branches (those that are within 4 inches, directly above, below, opposite or to one side) the selected scaffold. Make your selection on the basis of size, freedom from defect, attachment strength, angle of growth, and radial and horizontal spacing. Some of the less vigorous competing branches and smaller shoots can be left because they provide energy and will probably be shed over time.
- Ideal scaffold spacing is about 12 to 18 apart for larger species and about 8 to 12 inches for smaller species. If necessary, spacing can be improved as by further pruning as the tree grows. Uniform spacing is seldom achievable, so don't worry too much about it. It is more important to make sure that the scaffold's attachment is strong, and that branch distribution is relatively symmetric.
- Ideally, scaffold branches should be about 50 percent of the size of the trunk. Attachment strength decreases as the size ratio exceeds about 75 percent.
- Keeping the size of lateral branches to less than $\frac{1}{2}$ the diameter of the trunk or branches from which they grow, is an important goal.
- Branches that are the same or nearly the same diameter as the trunk or parent branch they arise from are called co-dominant stems. They usually form forks or V-crotches, which are prone to splitting. This potential problem can be corrected by removing one of the forks or pruning one of them back to a lower lateral, or thinning the foliage along one of the branches about 20 percent. This will suppress growth in the pruned branch while invigorating growth in the un-pruned branch, ultimately, changing the size ratio.
- It may also be necessary to thin foliage or branches along scaffolds to improve the branch/trunk size ratio.
- Avoid removing interior foliage and lower lateral along the scaffolds.
- For stability, $\frac{1}{2}$ of a tree's foliage should originate in the lower $\frac{2}{3}$ of the tree.

When removing an unwanted branch, there are several basic rules to follow:

- Remove unwanted branches at the trunk or parent branch where it arises. Do not leave a stub.
- Leave the branch collar (swollen area at the base) intact.
- Do not cut branches flush to the trunk.
- The practice of 'topping' or severely pruning young trees especially bare root trees, destroys natural structure, and can delay establishment.

Guidelines for Selecting and planting Bare Root Trees

Size: One-year old trees are called whips. They typically lack lateral branches and are the least expensive. Whip height generally range from 4 to 7 feet. Trees with branches are more than one year and are usually sold by height. Such trees have the beginnings of mature branch structure and often require some structural pruning/training. Trees taller than 8 feet usually are often sold by trunk caliper (stem-diameter measured 6 inches above the ground or graft union, as the case may be. Bare root trees larger 2-inch caliper are usually not readily available.

Quality: Select bare root trees that are free of kinked, bent ('J' or 'L-shaped) or circling roots. The roots system should appear healthy (succulent, not dry and withered), fairly symmetrical, e.g., good radial distribution. Reject trees with poorly formed or damaged roots. What to look for:

- A fairly straight trunk with a single leader (no competing laterals).
- Good branch distribution (radial and horizontal).
- Lateral branches less than 50% the diameter of the trunk.

Note: Standards listed above for containerized trees apply.

Planting: Dig the hole one and one half time the width of the roots to avoid having to bend the roots to make them fit. Do not cut roots to fit the planting hole. Make the hole only as deep as needed to accommodate the root system without causing cramping. Do not trim or cut roots unless a portion is dead, injured or kinked. Pruning roots indiscriminately at planting will only delay root regeneration, and increase transplant shock. Transplant shock is best overcome through proper planting, careful irrigation and favorable soil conditions. It is critical to keep the soil moist until sufficient roots regenerate. Place the tree in the hole and spread the roots out before backfilling. Carefully straighten bent or folded roots. Avoid excess bending, which may cause roots to break. When pruning is necessary use hand shears and cut back to the point just short of the damaged or kinked section. Roots should be positioned horizontally or angled down slightly downward from the trunk. You may lay the roots over a mound of firmly packed soil in the center of the planting hole. Carefully place backfill soil around the roots. You may also place the tree in the hole, holding it at the correct height and add carefully loosened soil to cover the roots. In either case, position so that the top-most roots are just under the soil surface. Be careful not to injure roots with the shovel used for backfilling. If practical, use your hands to backfill to avoid skinning the bark. Carefully pack the soil around the roots to ensure that there are no air pockets. Several waterings will help to settle the soil around the root system.

Staking:

- Use 2 stakes, one on either side of the root ball. Place the stakes so that they are at right angles to the prevailing wind.
- Tie the tree loosely to the stakes with flexible, commercial ties.
- Place the ties (usually 2) so that the tree's top moves freely in the wind. If the top bends too easily or leans perceptibly, move the ties up until the tree is more stable. Place the ties no higher than necessary. It is important that trees be allowed to move (4 to 6 inches) in the wind.
- Staple or nail the ties to the stakes.
- Avoid using cross-bars between the two stakes. This can limit movement and damage the trunk.

Additional:

- Bare root trees must be stored carefully until the time of planting. Cover the roots with moist sawdust, sand or loose planting mix during storage and until just before planting.
- Bare roots trees become available in late winter and early spring. Do not delay planting.
- Plant bare root by Feb. 15 for adequate time to regenerate roots before warm weather.